Chapter 8
Corrosion Control

8-1. General

Corrosion damage will occur over time and can impair structural and operational capacity of vertical lift gates. To minimize future structural problems and high maintenance and rehabilitation costs, resistance to corrosion must be considered in the design process. Vertical lift gates are subject primarily to localized corrosion (i.e., crevice corrosion or pitting corrosion), general atmospheric corrosion, or mechanically assisted corrosion. Brief theoretical discussions on corrosion are presented in EM 1110-2-3400, EM 1110-2-2704, ETL 1110-2-351, and CASE Steel Structures Task Group (1993). Prudent design and maintenance practices can minimize these types of corrosion. Corrosion of vertical lift gates is best controlled by application of protective coatings, but is also effectively controlled by proper selection of materials, cathodic protection, and proper design of details. The selection of corrosion protection alternatives is highly dependent on the particular environment in which the gate will function.

8-2. Coating Systems

Application of coating systems is the primary method of corrosion protection for vertical lift gates. Coating systems include alkyd enamel, vinyl, and epoxy paint systems. Thermal spraying (metallizing) should be considered when extreme abrasion is predicted or when local or state governments have restricted the use of volatile organic compounds. EM 1110-2-3400 provides detailed information on selection, application, and specifications of coating systems. An EM on thermal spraying is being developed. Construction Engineering Research Laboratories can also be contacted for additional information.

8-3. Cathodic Protection

Cathodic protection is often used in the more corrosive environments to supplement the paint coatings. Since corrosion is a continuing process of removing electrons from the steel, cathodic protection introduces a low current to counteract this effect. This essentially causes all parts of the structure to be cathodic. Cathodic protection is achieved by applying a direct current to the structure from some outside source. The direct current can be invoked either by impressed current or sacrificial anodes attached to the gate. Sacrificial magnesium anodes are often installed on gates used in fresh water when carbon and stainless steels are in contact with each other. For example, anodes would be used when a painted mild steel gate is in contact with stainless steel tracks and rollers and also in contact with the stainless steel guides through the bearing shoes, rollers, or wheels. Unfavorable area differences such as a small anode (less noble mild steel 99 percent covered with paint) and a cathode many times larger (more noble stainless steel bare) will cause rapid development of pits at holidays and other imperfections in the paint coating. Magnesium, being less noble than either mild steel or stainless steel, becomes a sacrificial anode and will protect these flaws in the paint coating and also protect oxygen-deficient areas on the stainless steel. To provide adequate protection, anodes must be within 600 mm (24 in.) and in line of sight of the surface they are protecting. Plate 12 depicts typical anodes installed on an emergency gate.

8-4. Control Contamination

Metallic contamination of the metal surface can cause galvanic corrosion. Nonmetallic contamination on stainless steel can result in loss of passivity at the contamination sites or create oxygen concentration cells, which can cause pitting. Such components as stainless steel rollers, wheels, axles, track plates, seal plates, and guides should be passivated after fabrication with a nitric acid solution according to ASTM A380-96 (ASTM 1996a). During manufacturing, metals may acquire contamination from metal forming and machining operations. Avoidance of contamination, or the discovery and removal of prior contamination on metals, is critical at the construction site during erection or installation of the structure or equipment.

8-5. Design Details

Structural detailing has a significant impact on the susceptibility of the structure to corrosion. Structures should be detailed to avoid conditions that contribute to corrosion. The following items should be considered in the design process:

a. Structural members should be detailed such that all exposed portions of the structure can be properly painted or coated.

b. Provide drain holes to prevent entrapment of water. Locate extra large drain holes in areas where silt or sand may be trapped.

c. Avoid lap joints, but where used, seal weld the joint so that water cannot be trapped between the connected plates.

d. Grind slag, weld splatter, or any other deposits off the steel. These are areas that form crevices that can trap water.

e. Where dissimilar metals are in contact (generally carbon steel with either stainless steel or bronze), provide an electric insulator between the two metals and avoid large ratios of cathode (stainless steel) to anode (carbon steel) area.

f. Use continuous welds in lieu of bolts where possible with caution given to the effect of or susceptibility to fracture.

g. Break or grind sharp corners or edges to a minimum 1-mm radius to allow paint or coating to properly cover the surface.

h. Avoid designs with enclosed spaces. If such spaces cannot be avoided, make them large enough for maintenance work and painting, or provide cathodic protection. In some gates it may be possible to fill and seal the space with a noncorrosive liquid or solid. This technique has been used on tanks for floating fish entrance gates.

i. Consider using corrosion-resistant metal for areas that will be inaccessible for replacement.

j. If anodes are used, allow enough room for maintenance workers to replace them.

8-6. Commentary

Crevices, areas where water may pond, locations where dissimilar metals are in contact, and areas subject to erosion all contribute to corrosion. Specifying a uniform increase in member component thickness provides a structure with increased resistance to corrosion damage. However, this is not effective for localized corrosion; the total structural cost is increased; and the increase in member resistance to tension, compression, and bending effects is not uniform. Before a protective coating is applied, steel must generally be sandblasted, so accessibility for sandblasting should be considered. A sandblasting hose generally cannot be bent sharper than a 600 mm (24 in.) diameter. In general, welded connections are more resistant to corrosion than bolted connections. In bolted connections, it is not possible to seal areas between plies. Water can penetrate the plies. Weld ends are particularly vulnerable to corrosion since these are areas where crevices exist. Where dissimilar metals are in contact, if the anode is large with respect to the cathode, corrosion will be slight. If only the carbon steel is painted and there is a small defect in the coating, the relative areas have a large ratio of cathode to anode area and rapid corrosion can occur. Therefore, it is best to paint both surfaces.

8-7. Safety

Corrosion may be the cause of catastrophic damage or loss of life due to failure of a gate or structural members of a gate. Particular attention must be applied to structural members that are inaccessible to inspection or accessible only for infrequent inspection. Of concern is fracture critical members. Prevention of corrosion failures shall be investigated during the design of the gate. Of major concern is placing human life at risk. Where corrosion failure will place human life at risk, the most current methods of corrosion control will be employed.